

Investigating the Potential Range Expansion of the Vector Mosquito *Aedes aegypti* in Mexico with NASA Earth Science Remote Sensing Results



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Team:

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Goal

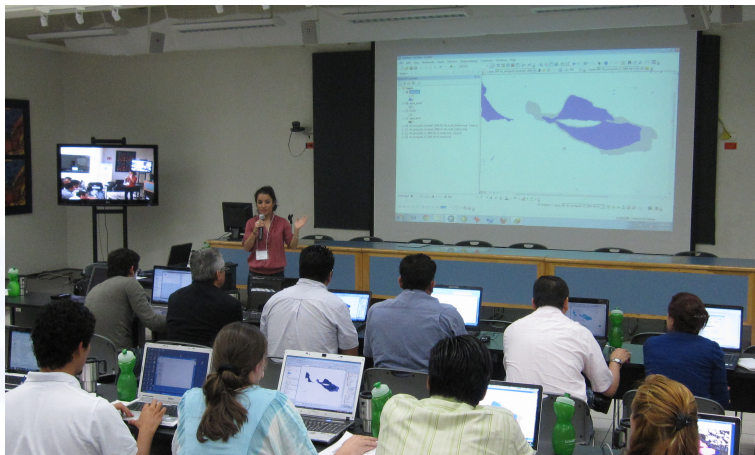
To facilitate the investigation and modeling of the social, economic, environmental, and epidemiological factors that control the survival and abundance of the mosquito vector *Aedes aegypti*, the primary transmitter of dengue viruses. The ultimate goal is to employ this integrated modeling approach toward understanding the potential range of *Aedes aegypti* to expand toward heavily populated high elevation areas such as Puebla and Mexico City under various climate change and socio-economic scenarios.

Objective 1

Employ NASA remotely-sensed data to augment environmental monitoring and modeling. These data -- surface temperature, precipitation, landcover, vegetation indices, soil moisture and elevation -- are critical for understanding mosquito habitat needed for survival and abundance.

Objective 2

Implement GIS and remote sensing training sessions to transfer remotely-sensed data products to end users and to facilitate continued monitoring



➤ **A training session was conducted at the University of Veracruz, Xalapa, 20-22 March 2012: ‘Introduction to SERVIR for decision-making through the use of GIS and remote sensing’.**

“Introduction to SERVIR for decision-making through the use of GIS and remote sensing”

“Introducción a SERVIR para la toma de decisiones a través del uso de SIG y teledetección”

Agenda

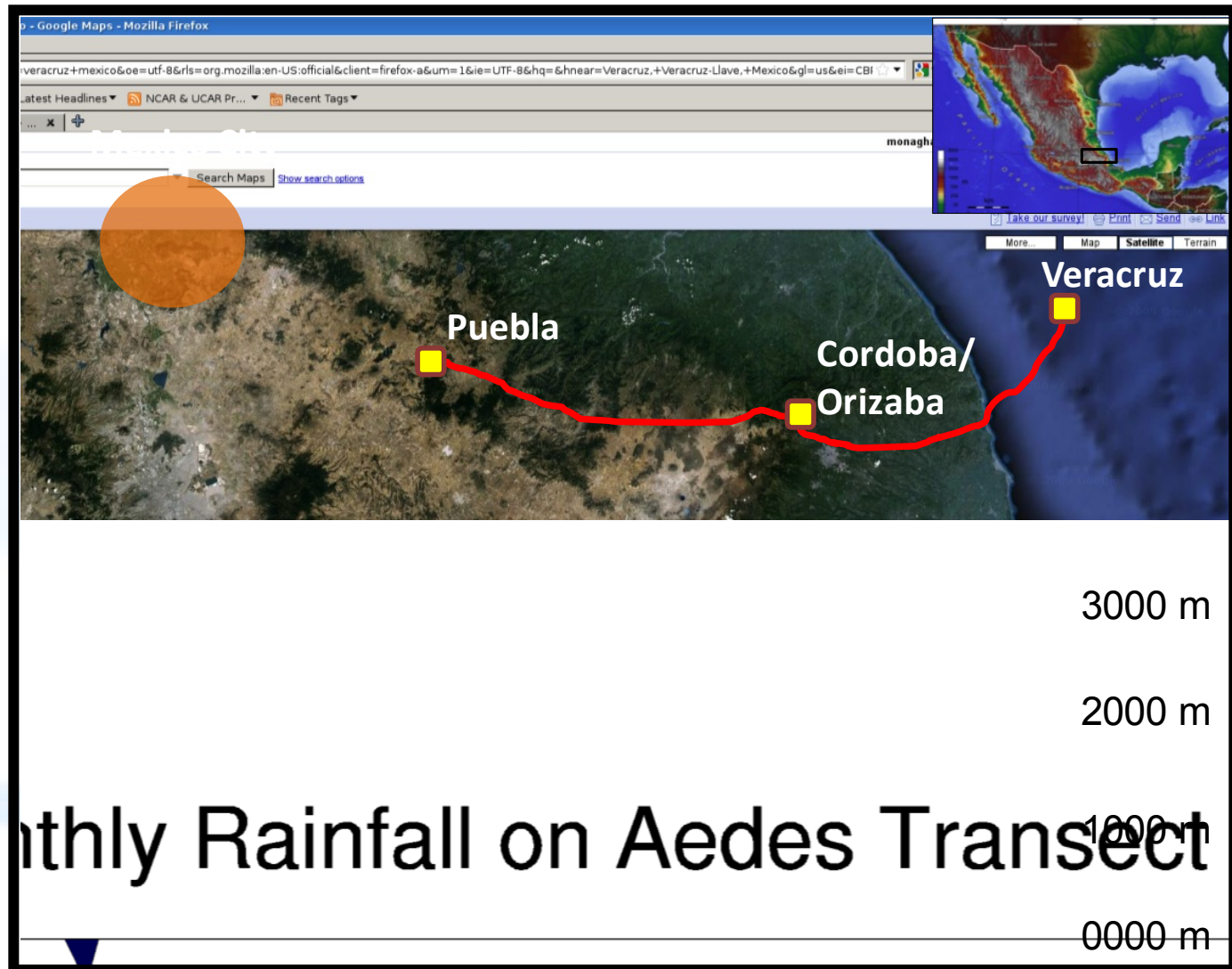
Xalapa, Mexico, March 20 – 22, 2012

Time / Hora	Activity / Actividad
Tuesday, March 20	
8:00 – 8:20 AM	Opening words / Palabras de Apertura
8:20 – 9:20 AM	Overview of Dengue Fever Project/ NCAR
9:20 – 10:00 AM	Overview of SERVIR / Descripción general de SERVIR
10:00 – 10:30 AM	Introduction to Remote Sensing / Introducción a teledetección
10:30 – 10:45 AM	Coffee Break
10:45 AM – 12:00 PM	Where/how to find and download satellite images / Donde/como encontrar y descargar imágenes satelitales
12:00 – 1:00 PM	Lunch
1:00 – 2:00 PM	Basic principles of Remote Sensing / Principios basicos de Teledetección
2:00 – 3:30 PM	Properties of Multispectral satellite images / Propiedades de imágenes Multiespectrales

Objective 3

**Integrate data products into the NASA
SERVIR framework to disseminate
key project results**

Sampling Transact



Project Outcomes

- First year of field work was conducted in summer 2011 to sample pupae, larvae and adult *Aedes aegypti* in 12 communities.
- Second year of field work conducted in summer 2012 to sample pupae and adult *Aedes aegypti* in 4 communities – Rio Blanco, Maltrata, Acultzingo, Puebla – at the habitat margin.
- Climate and remote sensing data have been collected for use in modeling and analysis.
- A climate-based model has been developed to predict potential presence of *Aedes aegypti* in households.



- A habitat suitability model has been developed and applied to predict presence of *Aedes aegypti* in households for 2011 and 2012.

Aedes aegypti habitat model

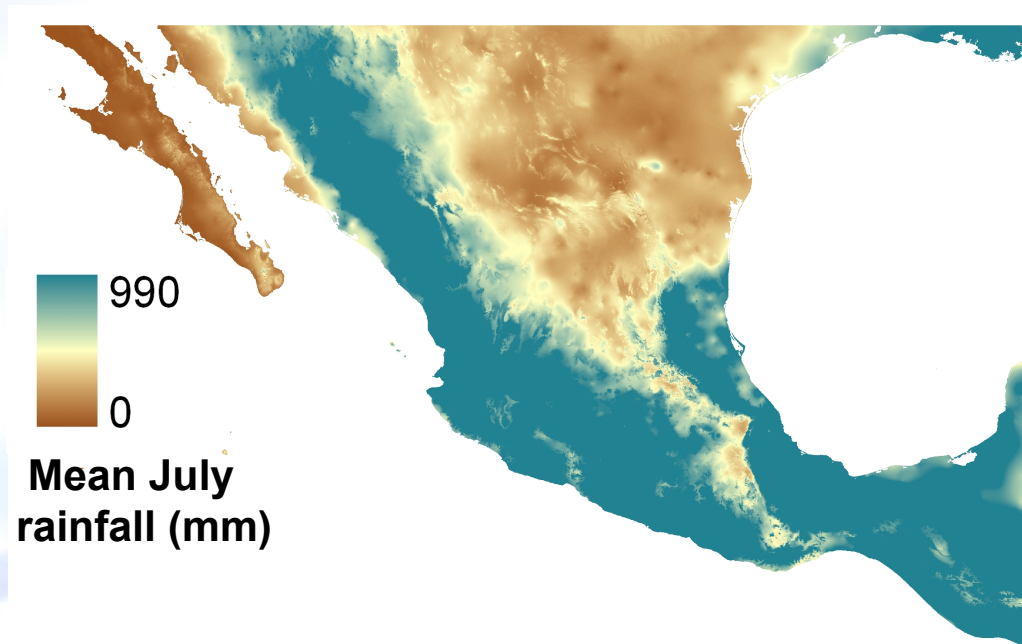
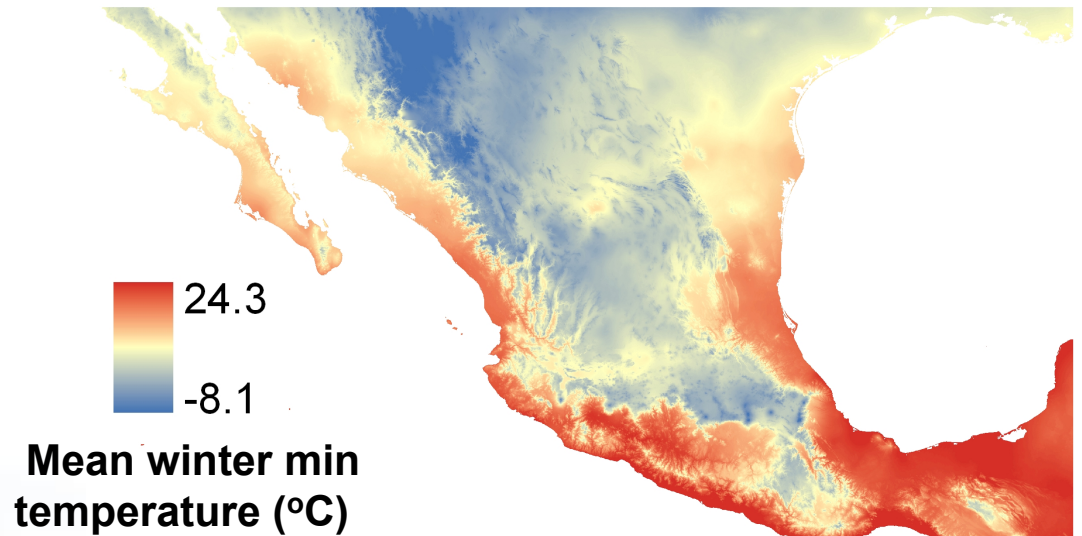
- A regression model was developed using 2011 *Aedes aegypti* field data and climatological inputs to estimate the spatial pattern of 'potential presence'.

- Independent variables from World Climate Data (1 km):

- ✓ Mean July min/max temperature, rainfall

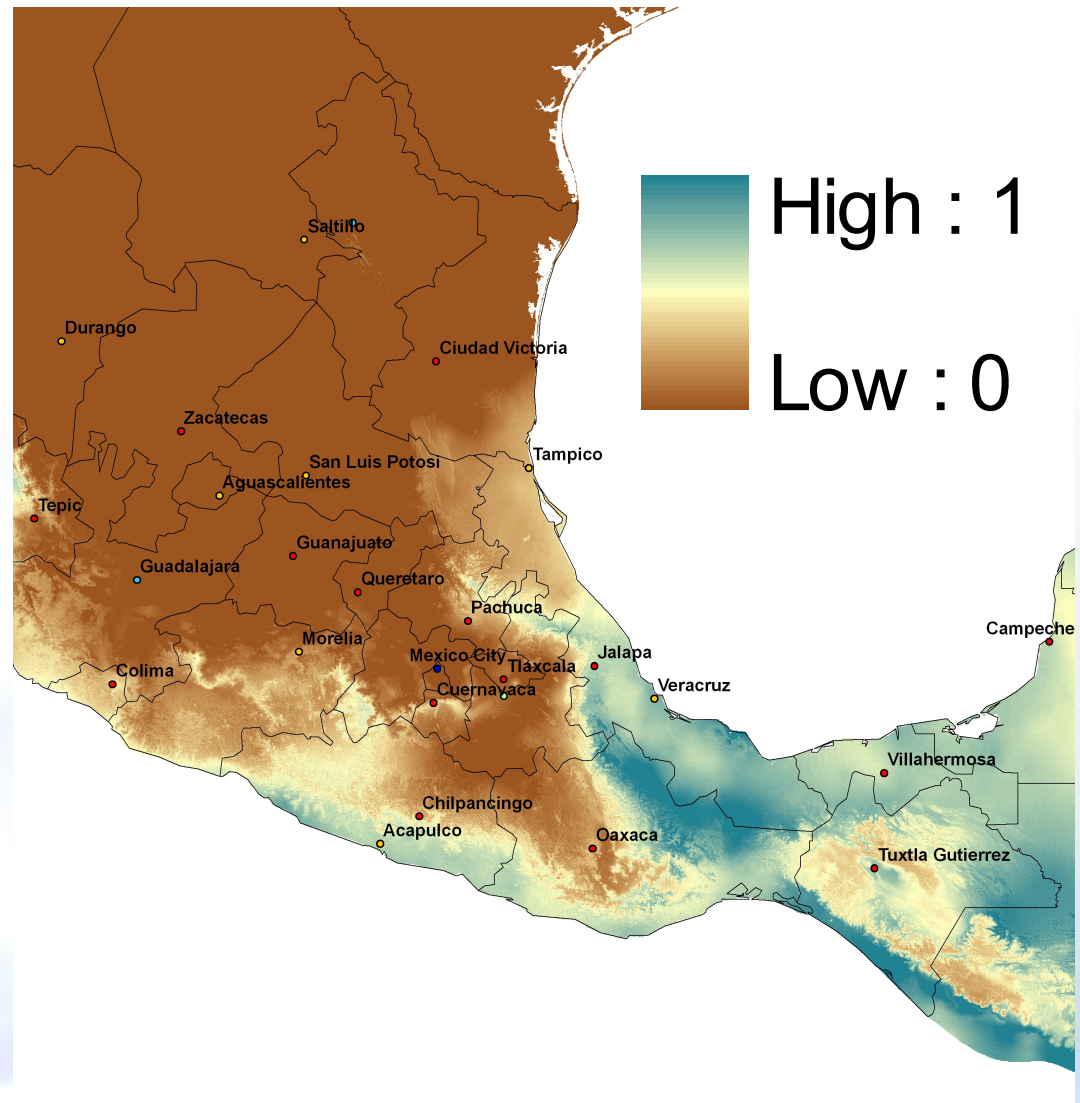
- ✓ Mean Dec-Feb min temperature

- ✓ Elevation (ASTER; 250 m)



Aedes aegypti habitat model

- Habitat is very sensitive to elevation and temperature



Aedes aegypti habitat model

- Another regression model was developed using 2011-12 field data to estimate the spatial pattern of *Aedes aegypti* presence. This model is based on NARR meteorological data (32 km) for respective year.

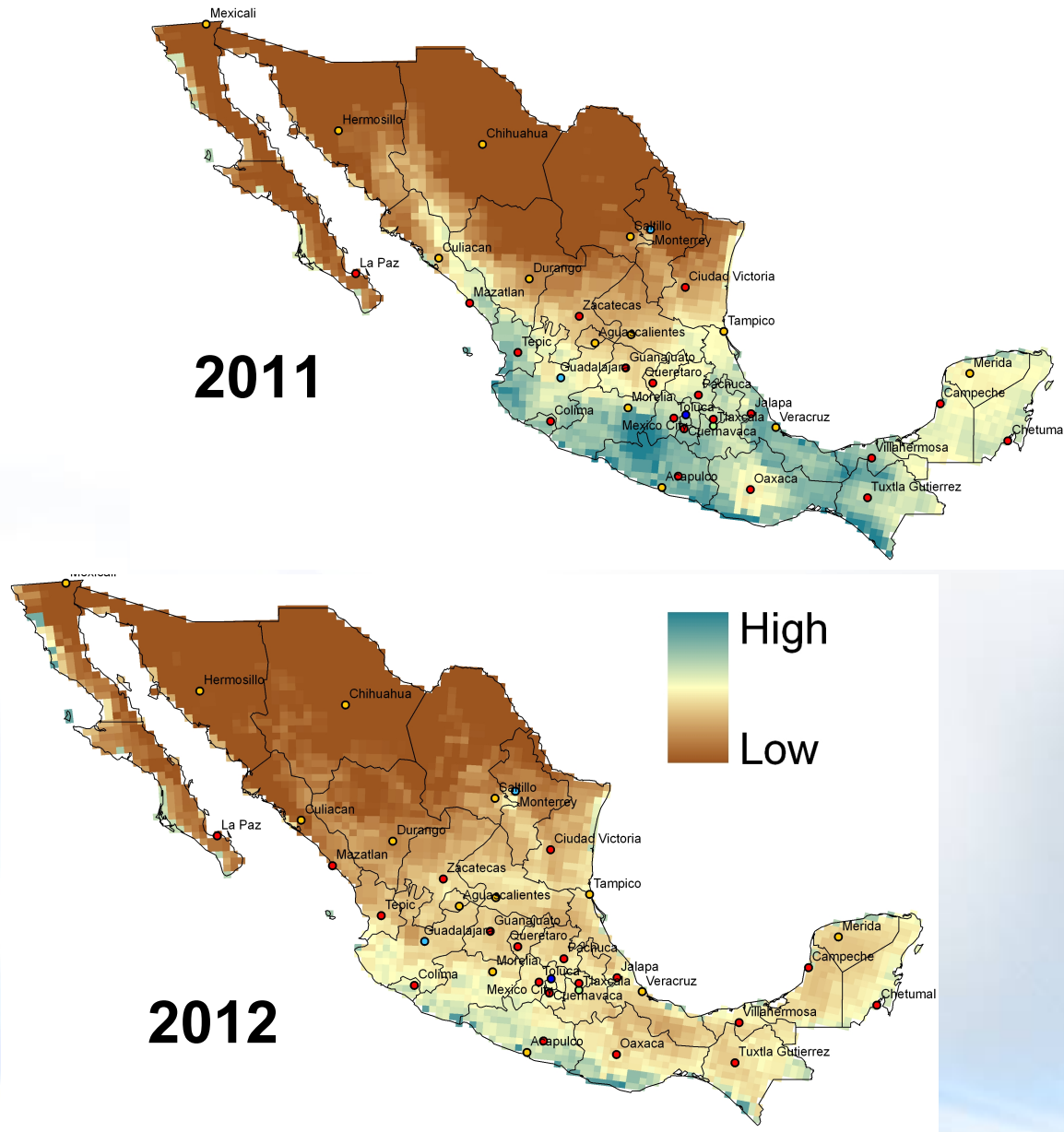
- Independent variables:

- ✓ Elevation (250 m)

- ✓ Mean July min/max temperature

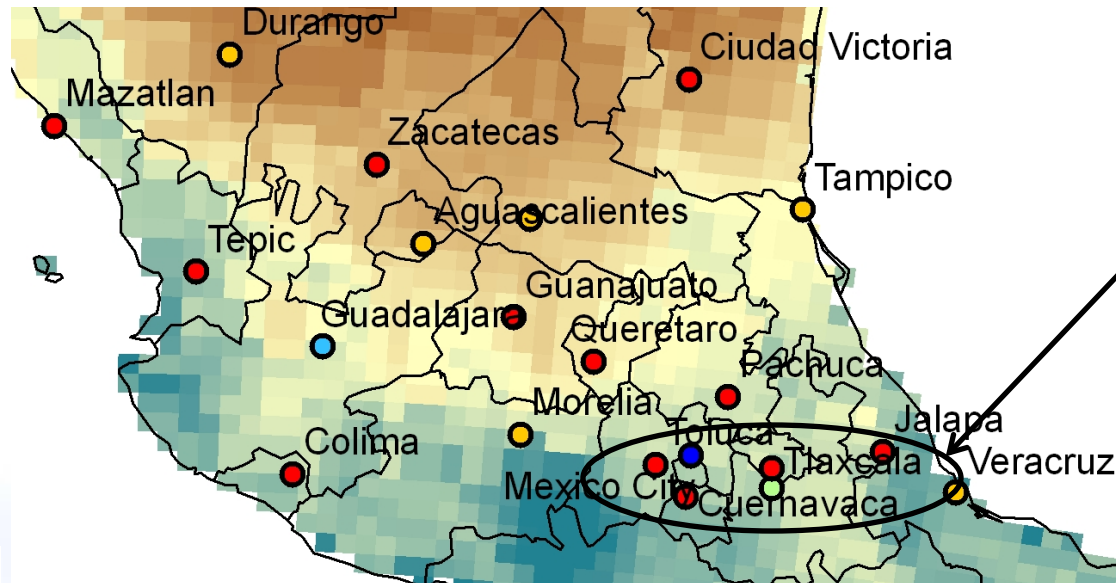
- ✓ Total July rainfall

- ✓ Previous Dec-Feb mean min temperature



Aedes aegypti habitat model

2011



Study area

2012



Fewer *Aedes aegypti* were observed in 2012.

Statistical Modeling of *Aedes aegypti*

- Principal Component Analysis was performed at the community level to identify best *Aedes aegypti* predictors among variables describing the natural environment:

- mean 60-day maximum temperature;
- 30-day rainfall;
- terrain elevation;

and the built environment:

- proportion of containers at ground level containing water.

A linear regression model was then developed using these independent variables. The regression r^2 of 0.852 is significant above 99% confidence level.

Data Products for SERVIR

➤ Remotely-Sensed Data for Southern and Central Mexico and parts of Central America:

- Land Cover Land Use 2009

➤ Map Products for Southern and Central Mexico:

- *Aedes aegypti* 'potential presence' (based on climatology)
- *Aedes aegypti* habitat suitability maps for 2011 and 2012 (based on weather)
- Suitability maps for the summer *Aedes aegypti* maximum will be generated by SERVIR each spring and updated in summer.
- Forecast for year will be in the form of spatial maps showing 'much below', 'below', etc. suitability for *Aedes aegypti*.

Applied Readiness Level (ARL)

- **Starting ARL: 2 (Application Concept)**
 - ✓ **Some field data collected through predecessor project**
 - ✓ **Need for habitat suitability mapping identified**

- **Ending ARL: 6 (Demonstration in Relevant Environment)**
 - ✓ **Environmental and household survey data collected**
 - ✓ **Habitat suitability model developed from environmental and survey data**
 - ✓ **Limited validation performed on model performance**

Costing Status

- **Work on the 2-year project began in May 2011. All funds have been received. All funds will be expended through September 2013.**

Impacts and Lessons Learned

- **Impacts**

Publications:

- **Several conference presentations**
- **One paper in development stage**

- **Lessons Learned**

- ***Aedes aegypti* discovered at higher elevations than previously reported**
- **There is very high variability in *Aedes aegypti* presence and abundance between households in a community; much of this is not explainable on first inspection.**

Issues

- Correlations between remotely-sensed environmental parameters (NDVI, LST, land cover) and *Aedes aegypti* presence/abundance are poor at the sub-community scale.



**WorldView-1 0.5 m panchromatic view of
Rio Blanco with households sampled**

Issues

- Remote sensing and modeling of *Aedes aegypti* habitat is difficult at the household level due to very small spatial scales.



Mosquito condominium